

Project X: The Accelerator

Fermilab, December 6, 2010

The Strategic Context and Fermilab's Future

For many years Fermilab has operated both the highest-energy particle collider and the highest-intensity accelerator-based neutrino beam in the world. Now the LHC is surpassing the Tevatron in energy and Japan's J-PARC facility is embarking on a long-baseline neutrino program in strong competition with the Fermilab program. In this international context, the US elementary particle physics community has adopted a strategic plan for the coming decade that emphasizes research on three frontiers: the energy frontier, the intensity frontier and the cosmic frontier. The plan recognizes that over the coming decade Fermilab will be the sole US site for accelerator-based particle physics research. Fermilab's strategy is fully aligned with the US plan. It features the development of a high-intensity proton source as the key to the long-term US program.

Evolution of the Fermilab Accelerator Complex

Project X is a multi-MW proton accelerator facility proposed for construction at Fermilab. It is based on an H⁻ linear accelerator using superconducting rf technology. Project X would be the linchpin for future development of the Fermilab accelerator complex, providing long-term opportunities at both the intensity and energy frontiers. Project X would provide great flexibility for intensity-frontier physics, creating the opportunity for a long-term world-leading program in neutrino physics and other beyond-the-standard-model phenomena. The technology for Project X also opens opportunities beyond traditional particle physics applications, for example in cold-neutron physics and accelerator-driven subcritical systems (ADS) for energy generation and the transmutation of waste. The technology development for Project X is closely aligned with the technologies required for the proposed International Linear Collider, preserving Fermilab's capability to serve as a host, or major contributor, to such a possible future accelerator. The development of multi-MW capabilities could also provide the basis for a future muon collider.

Project X Performance Criteria and Initial Configurations

The High Energy Physics Advisory Panel's P5 report provided the basis for the initial design criteria for a multi-MW proton source:

- A long-baseline neutrino beam facility based on a proton source capable of delivering at least 2 MW of beam power at any energy over the range 60-120 GeV
- High-intensity protons supporting muon and kaon precision experiments, simultaneous with the neutrino program
- A path toward a muon source for a possible future neutrino factory or muon collider

Physicists have developed two configurations that meet these requirements. The first uses an 8 GeV pulsed linac; the second incorporates a ~ 3 GeV continuous wave (CW) linac followed by an 8 GeV rapid cycling synchrotron (RCS) or superconducting pulsed linac. Both configurations use Fermilab's existing Recycler and Main Injector rings for beam accumulation and acceleration to 60-120 GeV.

Both configurations meet the requirements of a very-high-energy neutrino beam to support experiments in detectors located more than 1000 km away. However, the second (CW-linac based) configuration not only offers performance vastly superior to the first for a precision-measurements program, but also provides a capability that is unique among facilities being commissioned, constructed or designed worldwide.

Project X Collaboration

A “national collaboration with international partners” has formed to develop Project X. The national collaboration comprises Argonne National Laboratory, Brookhaven National Laboratory, Cornell University, Fermilab, Lawrence Berkeley National Laboratory, Michigan State University, Oak Ridge National Laboratory, Thomas Jefferson National Accelerator Facility, SLAC National Accelerator Laboratory, and the Americas Regional Team of the ILC Global Design Effort. Currently, the most significant international collaboration is with India, although the collaboration is also forming ties with other European and Asian institutions.

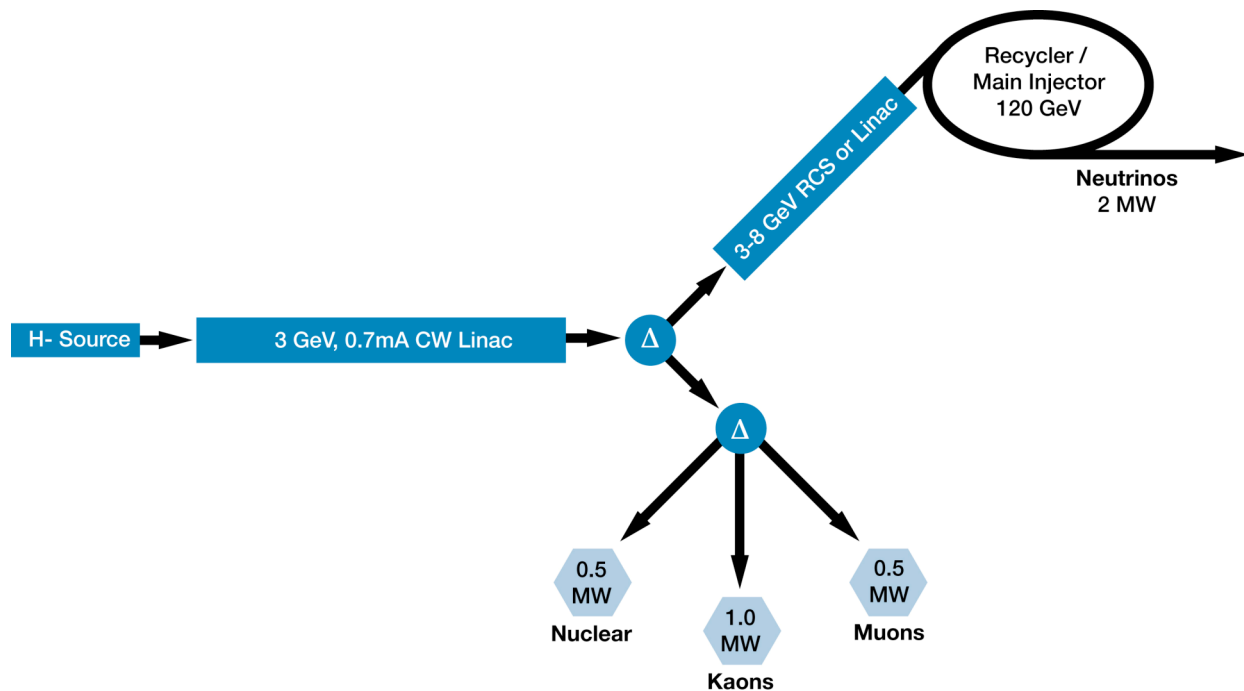
Construction Period

The earliest start dates for Project X, as communicated to Fermilab in fall 2009 are: PED funding FY2012, construction start FY2015.

Other Applications

The technologies required for Project X have broad potential applications in areas beyond research in elementary particle physics, including

- Accelerator-driven energy systems
- Rare isotope production for nuclear physics
- Neutron sources
- X-ray FELs
- Energy recovery linacs
- Muon facilities for materials research



Project X, a high-power proton facility, would support world-leading programs in long-baseline neutrino physics and the physics of rare processes. It would be unique among accelerator facilities worldwide in its flexibility to support multiple physics programs at the intensity frontier. Project X is based on a 3 GeV continuous-wave superconducting H- linac. Further acceleration to 8 GeV, injected into Fermilab's existing Recycler/ Main Injector complex, would support long-baseline neutrino experiments. Project X would provide 2 MW of total beam power to the 3 GeV program, simultaneously with 2 MW to a neutrino production target at 60-120 GeV. A multilaboratory collaboration with international participation has undertaken the development of Project X.